

## Swift Observation of GRB 110808A

*G. Stratta (ASDC), V. D'Elia (ASDC), B. Gendre (ASDC), T. A. Pritchard (PSU), T. Sakamoto (GSFC/UMBC), S.D. Barthelmy (GSFC), D.N. Burrows (PSU), E.A. Hoversten (PSU), N. Gehrels (GSFC) for the Swift Team*

### 1 Introduction

At 06:18:54 UT, the Swift Burst Alert Telescope (BAT) triggered and located the long GRB 110808A (trigger=458918, Stratta et al., GCN Circ. 12256). Swift slewed immediately, and the narrow field instruments were on target 111 seconds later. The X-ray telescope XRT detected a bright X-ray afterglow. The enhanced Swift/XRT position RA (J2000)=  $03^h 49^m 3.99^s$  and Dec (J2000)=  $-44^d 11' 43.3''$  with an uncertainty of 3.2 arcsec (radius, 90% confidence) was given by Osborne *et al.* (GCN Circ. 12257).

The BAT light curve shows a single-peaked structure with a duration of about 10 sec.

UVOT took a finding chart exposure of nominal 150 seconds with the white filter starting 120 seconds after the BAT trigger and it detected a candidate afterglow in the rapidly available  $2.7' \times 2.7'$  sub-image at RA(J2000) =  $03^h 49^m 04.28^s$  and Dec(J2000) =  $-44^d 11' 40.3''$ , with a 90%-confidence error radius of about 0.83 arcseconds. This position is 5.1 arcseconds from the center of the XRT error circle. The estimated magnitude is 19.93 mag with a  $1 \sigma$  error of about 0.19 mag, not corrected for the expected extinction corresponding to E(B-V) of 0.01.

The optical afterglow was also imaged by X-shooter mounted at ESO-VLT (de Ugarte Postigo et al. GCN Circ. 12258) which detected several emission and absorption lines at the common redshift  $z=1.348$ .

### 2 BAT Observation and Analysis

Using the data set from  $T - 471$  s to  $T + 639$  s the BAT ground-calculated position is RA, Dec = 57.322, -44.177 deg which is RA(J2000) =  $03^h 49^m 17.2^s$  and Dec(J2000) =  $-44^d 10' 35.4''$  with an uncertainty of 2.7 arcmin (radius, sys+stat, 90% containment). The partial coding was 76%.

The mask-weighted light curve shows a FRED pulse shape starting at  $\sim T + 0$  sec, peaking at  $\sim T + 1$  sec, and returning to the baseline at  $\sim T + 50$  sec.  $T_{90}$  (15-350 keV) is  $48 \pm 23$  sec (estimated error including systematics).

The time-averaged spectrum from  $T - 7.4$  s to  $T + 40.6$  s is best fit by a simple power-law model. The power law index of the time-averaged spectrum is  $2.32 \pm 0.43$ . The fluence in the 15-150 keV band is  $(3.3 \pm 0.8) \times 10^{-7}$  erg  $\text{cm}^{-2}$ . The 1-sec peak photon flux measured from  $T + 0.06$  s in the 15-150 keV band is  $0.4 \pm 0.2$  ph  $\text{cm}^{-2} \text{s}^{-1}$ . All the quoted errors are at the 90% confidence level (Sakamoto et al. GCN Circ. 12262).

The results of the batgrbproduct analysis are available at <http://gcn.gsfc.nasa.gov/notices.s/458918/BA/>

### 3 XRT Observations and Analysis

From 100 s to 761.4 ks after the BAT trigger, the Swift/XRT data comprise 91 s in Windowed Timing (WT) mode (the first 9 s were taken while Swift was slewing) with the remainder in Photon Counting (PC) mode. The enhanced XRT position for this burst was given by Goad et al. (GCN. Circ 12257).

The light curve can be modelled with an initial power-law decay with an index of  $\alpha_1 = 3.79_{-0.20}^{+0.22}$ ,

followed by a break at T+475 s to a new decay index  $\alpha_2 = 0.51_{-0.14}^{+0.15}$ . A second break is observed at T+54.6 ks where the light curve steepens to a decay index  $\alpha_3 = 1.1_{-0.2}^{+2.5}$ . A spectrum formed from the WT mode data can be fitted with an absorbed power-law with a photon spectral index of  $3.07_{-0.25}^{+0.29}$ . The best-fitting absorption column is  $2.9_{-1.3}^{+1.4} \times 10^{21} \text{ cm}^{-2}$ , at a redshift of 1.348 (de Ugarte Postigo et al. GCN Circ. 12258), in addition to the Galactic value of  $1.0 \times 10^{20} \text{ cm}^{-2}$  (Kalberla et al. 2005). The counts to observed (unabsorbed) 0.3-10 keV flux conversion factor deduced from this spectrum is  $2.2 \times 10^{-11}$  ( $3.5 \times 10^{-11}$ )  $\text{erg cm}^{-2} \text{ count}^{-1}$  (Stratta et al. GCN Circ. 12261).

Detailed light curves in both count rate and flux units are available in both graphical and ASCII formats at [http://www.swift.ac.uk/xrt\\_curves/00458918](http://www.swift.ac.uk/xrt_curves/00458918).

## 4 UVOT Observation and Analysis

The Swift/UVOT began settled observations of the field of GRB 110808A 120 s after the BAT trigger (Pritchard et al. GCN Circ. 12264). A source consistent with the Enhanced Swift-XRT position (Goad et al., GCN Circ. 12257) is detected in the initial UVOT exposures. The preliminary UVOT position is RA (J2000) =  $03^h 49^m 04.27^s$  and Dec (J2000) =  $-44^d 11' 40.1''$  with an estimated uncertainty of 0.64 arcseconds (radius, 90% confidence). Preliminary detections and 3-sigma upper limits using the UVOT photometric system (Poole et al. 2008, MNRAS, 383, 627) for the early exposures are quoted in Table 1 and plotted in Figure 3. The magnitudes in the table are not corrected for the Galactic extinction due to the reddening of  $E(B-V) = 0.01$  in the direction of the burst (Schlegel et al. 1998).

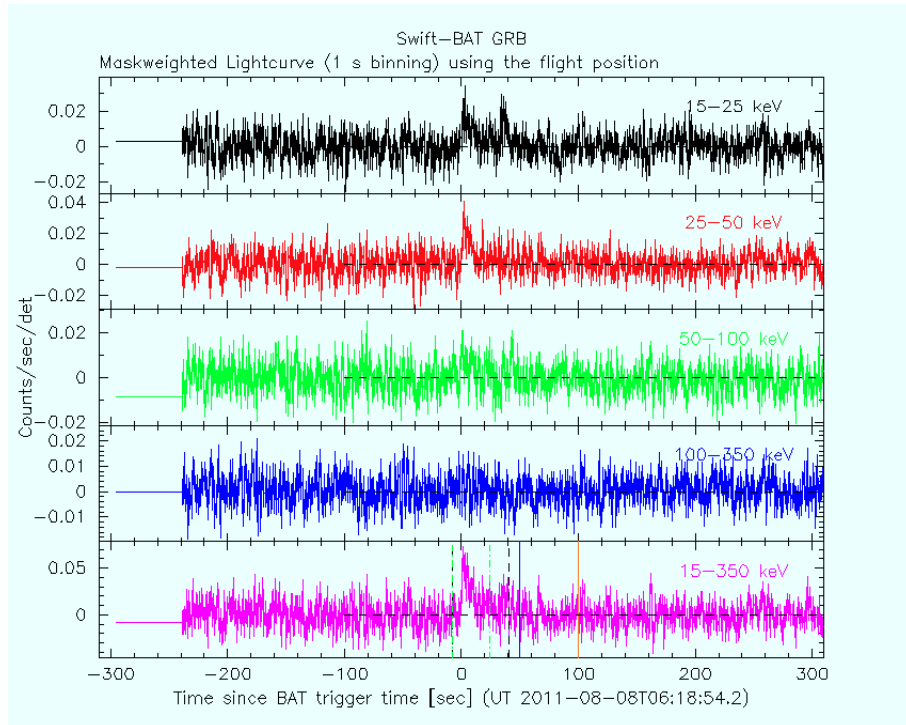


Figure 1: BAT Light curve. The mask-weighted light curve in the 4 individual plus total energy bands. The units are counts  $\text{s}^{-1} \text{ illuminated-detector}^{-1}$  (note illum-det =  $0.16 \text{ cm}^2$ ).

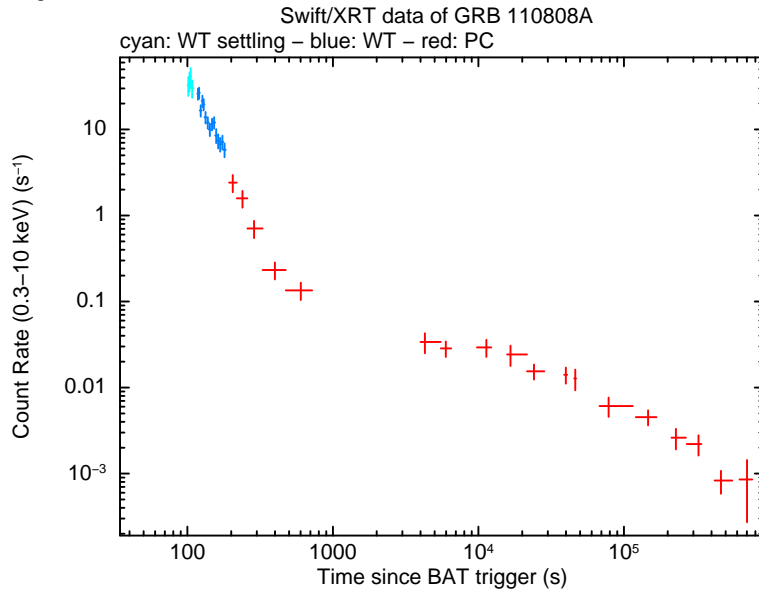


Figure 2: XRT Lightcurve. Counts  $s^{-1}$  in the 0.3-10 keV band: Window Timing mode (blue), Photon Counting mode (red). The approximate PC data conversion to observed (unabsorbed) flux is  $1 \text{ count } s^{-1} \sim 3.1(3.2) \times 10^{-11} \text{ erg } cm^{-2} s^{-1}$ .

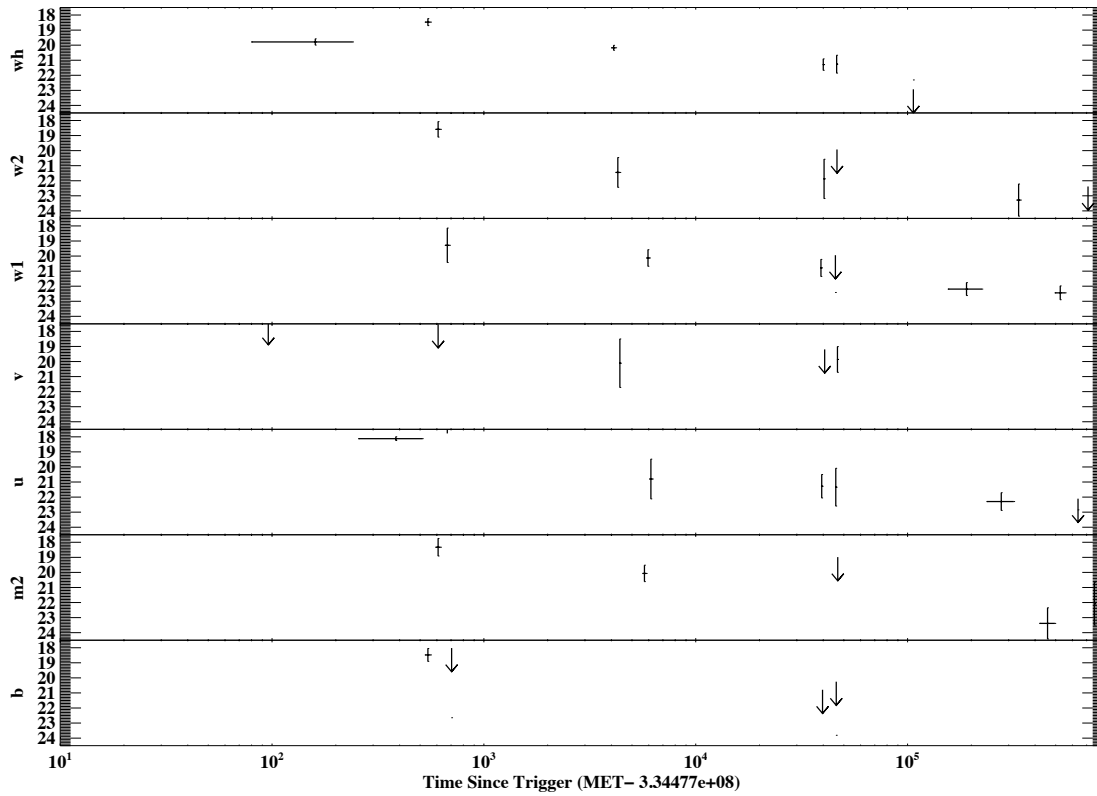


Figure 3: UVOT light curves.

Filter	T_start (s)	T_stop (s)	Exp (s)	Mag
white	120	270	147	$19.88 \pm 0.14$
white	57	559	19	$18.48 \pm 0.23$
white	3996	4196	200	$20.17 \pm 0.16$
v	609	629	19	$>18.7$
b	535	555	20	$18.64 \pm 0.32$
u	279	528	246	$18.28 \pm 0.09$
u	683	703	19	$17.48 \pm 0.25$
u	6062	6262	196	$>20.62$
w1	658	678	19	$>17.8$
w2	585	605	19	$>18.3$

Table 1: Magnitudes from UVOT observations.